

## BGS Focal Plane Detector Upgrade

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The Berkeley Gas-filled Separator (BGS) focal plane detector array has been upgraded. A large-area position sensitive Si-strip detector has been constructed for measurement of a) energy, b) position, and c) time of 1) implantation of heavy ions after passing through the BGS, 2) the subsequent  $\alpha$ -decay of these heavy ion nuclei, and 3) their possible spontaneous fission.

The focal plane detector array (see FIG. 1) is constructed from 60-mm x 60-mm Si-strip detectors from Canberra Semiconductor. These detector chips are fully depleted with a thickness of 300  $\mu$ m and an active area of 58 mm x 58 mm. Each detector chip has 16 vertical strips. The detector chips were glued to circuit boards, and all connections were made by wire bonding. The circuit boards were then mounted on a delrin frame, and connections to the preamplifiers were made via coaxial cables and LEMO vacuum feedthroughs. The focal plane itself consists of three of these chips, resulting in an effective size of 180 mm wide x 60 mm high. With the BGS horizontal magnetic dispersion of approximately 1.8 mm / %, this upgraded focal plane detector covers 10% in magnetic rigidity. This focal plane detector chips are surrounded by a set of eight “upstream” detector chips, for reconstructing the energies of  $\alpha$ -particles which escape the face of the focal plane detector chips. With the upstream detectors, the efficiency for detection of  $\alpha$ -particles is greater than 75%. Directly behind the three focal plane detector chips (which have been mounted in a transmission configuration on modified circuit boards) lie a second set of three identical chips. These “punchthrough” detectors allow discrimination against high-energy light ions which pass through the focal plane detector chips.

The focal plane section is fully instrumented (separate signals taken from the top and bottom of each of the 48 strips). The upstream and punchthrough detectors have been electrically connected to four strips per segment (four segments per detector chip), resulting in 32 upstream segments and 12 punchthrough segments (with no “vertical” position sensitivity). The detector is run at room temperature. The energy resolution at any given position is  $\sim 40$  keV full-width at half-maximum (FWHM). With an incomplete compensation for effects due to vertical position and horizontal strip number, the energy resolution for spectra summed over the whole focal plane array is 60 keV FWHM. Horizontal positions are determined by identifying in which of the 48 3.62-mm wide vertical strips the event occurred. Vertical positions are determined by resistive charge division. The vertical position resolution,  $\sigma_p$ , is approximately 2.8 mm\*MeV/E, where E is the recorded energy. This results in a FWHM for the vertical position difference between two 8-MeV  $\alpha$  particles of 0.9 mm, and over 1500 effective “pixels” over the full focal plane detector.

An automated energy and position calibration program has been developed for use with this detector array. Calibration

data from a four-peak source ( $^{148}\text{Gd}$ ,  $^{239}\text{Pu}$ ,  $^{241}\text{Am}$ ,  $^{244}\text{Cm}$ ) are recorded. The automated fitting procedure determines energy and vertical position calibrations for each of the focal plane strips, and energy calibrations for the upstream segments.

The BGS focal plane detector array is modular. The detector and all connectors are mounted to a single vacuum cover plate. This allows easy removal of the detector array so the BGS can be used with other detectors, or for repair of wire bonds or replacement of detector chips.

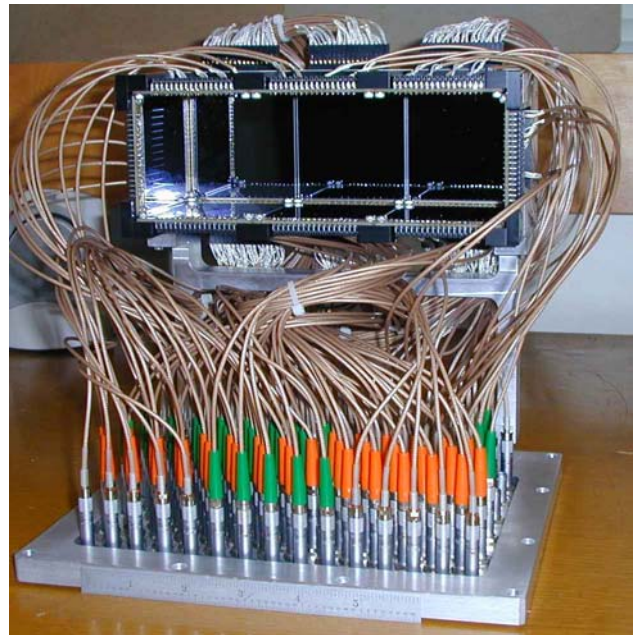


FIG. 1: The BGS focal plane Si-strip detector array. The three focal plane detector chips are surrounded by eight chips forming a five-sided box. The punchthrough detector chips are directly behind the focal plane detector chips.